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PLANNING AND ALLOCATION OF RESOURCES FOR DEVELOPMENT RESEARCH: THE LATIN AMERICAN EXPERIENCE

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CONTENT

Introduction and Summary

The main objective of this paper is to present a general view of research planning in Latin American and Caribbean countries, with a more in-depth analysis of one case in the region: that of agricultural research in Colombia. The first section of this paper makes some general considerations on science and technology policy in the countries of the region, and of the role research planning plays within this context. Emphasis is placed on the principal functions of research planning, and on the main aspects or types of criteria that have been taken into consideration in defining research priorities. The second section presents some general characteristics of the regional scientific community. The main purpose of this section is to provide information on the major areas in which research concentrates in the region, and on the institutional location of the research community (i.e. relative importance of the university research community, government research centres and private research institutions). The third section analyses some of the problems related to the identification of inter-sectorial research priorities, and to the allocation of resources for research among different sectors of government action. In doing so, it points out certain rigidities that generally appear in the resource-allocation process. Some of the limitations that social science research confronts, in mobilizing local support for this area of research, are analyzed in the context of inter-sectorial resource allocation.

The fourth section presents a more in-depth analysis of an outstanding case of research planning in the region: the identification of agricultural research priorities in Colombia. The fifth section points out some of the main weaknesses and limitations that the research planning experiences have faced. The weaknesses identify some of the main topics which require more attention and improvement in the future, such as those of research evaluation (evaluation of research projects and research programmes) and of development-impact analysis (the interface between research and development). Additional information on other research planning experiences in the region is provided in the annexes of this paper.

1. Science and Technology Policy in Latin America and the Caribbean

Science and technology policy has to do with the identification of the different ways in which scientific and technological knowledge can be generated, improved and/or applied to improving the living conditions of people, or to solving specific problems of socio-economic development. As such, science and technology become factors of production or instruments for development.

A series of studies carried out in the late fifties and sixties demonstrated the limitations of the traditional production factors (capital and labour) in explaining economic growth. As a result, the following years witnessed a growing interest in two additional factors that could be used to explain or promote economic development: education (or training of human resources), on the one hand, and the practical use of science and technology, on the other. Both factors are deeply interrelated, since the latter is to a large extent dependent upon the former. This interest led to the efforts that have appeared in various countries, oriented towards promoting national scientific and technological activities, and to orient them towards local economic and social needs. Thus a new dimension was introduced in national development planning.

Towards the end of the 1960's and the beginning of the 1970's most countries in the Latin American and Caribbean region created science policy organizations for the purpose of promoting research and the use of science and technology as a factor of development. Two types of organizations have appeared in these countries:

a) National Councils for Scientific and Technological Development.

b) Science and Technology Offices (or units) within National Planning Agencies.

Annex I provides a list of the science policy organizations of each country, with the respective date in which it was established, classified into one of the two organizational types previously mentioned.

The efficiency of these institutions and their contribution to the promotion of research in the region varies from one case to another. In general terms, these organizations have played an important rol in bringing to the attention of governments the importance of research for development, and, to a certain extent, in increasing the budget allocations for such activities. In several cases, they have been able to formulate science and technology policies and development programs, including sectorial research programs in areas of interest to each country. But the extent to which they have been able to implement such policies and programs has been much more limited. Three important factors that have influenced their capacity to implement research programs and science and technology policies have been the following:

a) The relative position of these organizations within the overall governmental structure (i.e. in certain cases these organizations occupy a marginal position within their respective governments).

b) The existence of a financial mechanism (i.e. national fund or influence on the allocation of financial resources), that allows them to implement the policies and programs they formulate.

c) The influence they are able to exert on the local scientific community and the institutional research infrastructure (this refers to the credibility such organizations have with the scientific community they are supposed to influence).

In some cases one or several of these factors have limited the capacity of these organizations to implement the policies and programs that have been formulated. In those cases where the science policy organization has not been linked to a national research fund (or some similar mechanism), science policy and sectorial research programs have basically remained at the level of academic exercises. This is particularly important since it should be realized that external technical and financial assistance (both multilateral and bilateral) can only be a complement to, but not a substitute for, national support for research and technological development.

Despite these limitations, science policy organizations have been one of the principal factors that have contributed to the increasing interest on research and the expansion of scientific and technological activities, in the Latin American and Caribbean countries.

An additional problem of science and technology policy is the complexity of the aspects it covers. In fact, research policy is only a very small part of science and technology policy. The latter covers many other things, such as the promotion of engineering services, extension services, technical assistance to industry, access to scientific and technical information, technology transfer and adoption, etc. Nevertheless, this paper will only make reference to research policy.

Research policies and (sectorial) research programs play three major roles in developing countries. In the first place, they allocate scarce resources (mainly human and financial resources) to multiple competing research topics or issues. This "resource allocation function" is very important in developing countries, given the scarcity of the resources available and the multiplicity of development problems these countries face. Secondly, research policies and programs try to develop and strengthen the links between the research community and the potential users of research results. This "linkage function" is achieved by involving both researchers and users (i.e. producers) in the research planning process (participatory approach). Thirdly, by concentrating research efforts in certain topics or problems, research policies attempt to influence or to shape the supply of technology in any given sector, or to adapt (or improve) existing technologies to specific local requirements and needs. This "technical change function" is the main objective and "raison d'être" of any research policy or research effort, specially in the case of development-oriented research. The latter will always be judged, in the last analysis, by its contribution to development. This relates research planning to two closely related topics: that of the evaluation of research programs (research evaluation), and that of the "development impact analysis" of research projects or research efforts. In a dynamic research planning process, these two last aspects (i.e. research evaluation and development impact analysis) should be fully integrated into it, in order to provide valuable feedback for the first two functions of research planning: the resource allocation and the linkage functions (this will be analyzed in more detail in section 5 of this paper).

In carrying out research evaluation and development impact analysis, one should be aware that technical change (the adoption of new technologies) is not only determined by the availability of "adequate" technologies (or research results). The existence of such technologies is a necessary, but not sufficient, condition, for technology adoption and development activities to take place. This is quite often a fallacy of the "voluntaristic view" of technical change. The latter involves additional factors such as credit facilities and extension services (technical assistance), which are normally part of development programs (of a regional or sectorial nature). This is where research has to be closely related with government development programs, if it is to have any development impact at all.

Given this general framework within which research planning takes place, we will now concentrate our analysis in the first function of research planning: that of resource allocation. Throughout the Latin American and Caribbean region, the science policy organizations mentioned above have formulated sectorial research programs (in a few cases technological development programs) related to such sectors as:

a) Agricultural research and food production.

b) Food processing and food technology.

c) Health research and health services.

d) The utilization of marine (or ocean) resources.

e) Energy research and the development of alternative energy resources.

f) Certain industrial branches have received attention in terms of the need of promoting their technological development (i.e. microelectronics, metallurgy and metalworking industry, etc.).

g) Forestry research, both for purposes of reforestation and the utilization of forestry products.

h) Geoscience research and mining resources.

Annex II of this paper presents a list of some of the main examples of sectorial research programs in Latin American and Caribbean countries that have been formulated in the above mentioned sectors. The most successful programs in terms of their degree of implementation have been those that have been actually related to a specific resource allocation mechanism in their own country, or that have been linked to a funding mechanism that has made it possible to support and carry out the different components of those programs. In other cases where this link has not existed, the research planning exercises have not gone beyond being interesting academic and intellectual exercises, with very little influence on what actually goes on (or is not carried out) in the country. In certain cases this reflects the weaknesses mentioned above of the science policy organizations themselves.

By "success" we refer here to the possibility of implementing and actually carrying out the specific activities or projects defined in a given sectorial research program. There is much less information f the degree of success at a second and much more important level, which is that of development impact, given the weaknesses of the research evaluation procedures and mechanisms throughout the region. We will come back to this point in the last section of this paper.

In determining research priorities for resource allocation purposes, most of the sectorial research and development programs in the region have generally used a combination of two or more of the following criteria or sources of information:

a) The development objectives one would like to maximize in that sector (i.e. increased food production, employment generation, improvement of health services, increased income for the local population, etc.).

b) The main production problems or development problems that are confronted in that sector. This information normally comes either from diagnostic studies describing such problems, or from "personal knowledge" of the problems that exist in a given sector or region. A variety of delphic techniques have been used to collect and systematize the personal knowledge that researchers, extension people, policy makers or producers have of such problems. In other cases, participatory research approaches have been developed, trying to integrate the personal knowledge of the producers in the research process itself.

c) The specific characteristics of the target population and f the constraints (i.e. resource constraints) under which this population operates. These characteristics may define what type of technologies are viable and which are not.

d) Prospective considerations: this refers to longer term considerations, either in terms of the future characteristics one would like to develop in the society (development options), or in terms of the implications for development that new technologies may have in opening or limiting production possibilities, or in changing the importance of specific natural resources or raw materials (technological forecasting and technological assessment). These prospective considerations have been the most difficult ones to handle, and quite often they have been totally absent /1.

e) Finally, sectorial research programs have taken into consideration the present supply of available technologies as one of their main starting points. In many cases, technologies may already be available for the solution of the problems identified, the question becoming one of facilitating access to such technologies (i.e. technical

1. For an interesting review of some of the main issues and problems faced in the prospective approach to research planning and technological development, see Victor Manuel Gomez: Planeacion Prospectiva de la Politica Cientifica y Tecnologica; Bogota, COLCIENCIAS, February of 1984.

assistance and information), or of adapting them to local conditions (adaptive research). Thus, the present supply of technologies and of technological know-how (both within each country and at the international level), is a basic starting point for the determination of research priorities in any given sector.

The relative weight given to these different factors or criteria has varied from one case to another. In the fourth section of this paper we will analyze the experience of one of these sectorial research and technological development programs: the one related to agricultural research in Colombia (Plan de Investigacion Agropecuaria del ICA - PLANIA, 1981). Annex II of this paper provides a list of other similar efforts, in other sectors and other countries of the region.

2. The Regional Scientific Community: Areas of Concentration and Institutional Location

The heterogeneity of the countries in the region is quite evident in the different size of their national research communities, and in the substantial differences of research capacity and research infrastructure that exists among them. In terms of the size of the national research communities (as measured by the number of researchers), we can distinguish three groups of countries in the region /2.

a) The large countries already have quite a significant research community: 8,250 researchers (Argentina), 10,400 researchers (Mexico), and 24,000 researchers (Brazil).

b) The medium sized Andean countries have research communities that fluctuate between 1,500 and 4,000 researchers (this refers to Venezuela, Colombia, Ecuador, Peru, Bolivia and Chile). If the number of equivalent full-time researchers was available for all countries, the corrected (and more realistic) figures should be between 1,500 and 2,500.

2/. The statistical information provided in this section comes from surveys carried out in Latin American and Caribbean countries in the 1978 to 1980 period. The present 1985 figures should be slightly above the ones presented in this section.

c) The smaller countries of Central America and the Caribbean have research communities that fluctuate between 200 and 800, with most cases below 500 (with the exception of Cuba).

If we compare the size of the national research communities to each country's total population, we find that most countries of the region have between 10 and 30 researchers per 100,000 inhabitants. This is substantially below the level of developed countries. In the latter case, the respective ratios mostly range between 100 and 250 researchers per 100,000 inhabitants, with a few cases above that level /3.

The inter-country differences are even bigger in terms of the financial resources that the different governments of the region allocate to research.

Institutional Location of the Regional Scientific Community

Despite these differences among the countries of the region, there are many similarities in terms of the institutional structure of the scientific community in the region, and in terms of the main research areas in which work is being carried out in the region. There are three main institutional (or organizational) sectors in which research is being carried out:

a) Universities

b) Government research centres (including public enterprises)

c) Private research centres

Tables 1 and 2 show the distribution of the research effort in terms of the three main institutional sectors we are considering. From these two tables it is quite clear that although the highest concentration of researchers is found in the universities (i.e. 69.4% in Venezuela, 64.6% in Brazil , 57.7% in Costa Rica), as well as the highest number of research projects (see table 1), the large

3/. For further information on the evolution of university training in the region, the educational profile and educational level f the regional research community and on its publishing behaviour, see Fernando Chaparro: 1982 IDRC Regional Report: Research in Latin America and the Caribbean and IDRC Programs in the Region; Bogota, IDRC (LARO), 1982. See also F. Sagasti, F. Chaparro, C. Paredes and H. Jaramillo: "Ciencia y Tecnologia en America Latina", in Comercio Exterior, Mexico, vol. 34, no. 12, December 1984, pp. 1163-1179.

TABLE 1

NUMBER OF RESEARCHERS BY INSTITUTIONAL SECTOR IN A GROUP OF LATIN AMERICAN COUNTRIES

Countries	Institutional Sector				
	Universities	Govt.Research Centres*	Private Research Centres**	Others	TOTAL
1. Brazil (1978)					
- No.	15,518	8,497	n.a.	--	24,015
- %	64.6	35.4	n.a	--	100.0
2. Mexico (1980)					
- No.	3,832/1	5,685/1	718/1	177/1	10,412
- %	36.8 /1	54.6/1	6.9/1	1.7/1	100.0
3. Colombia (1978)					
- No.	638	666	145	--	1,449
- %	44.0	46.0	10.0	--	100.0
4. Ecuador (1979)					
- No.	306	396	64	--	766
- %	39.9	51.7	8.4	--	100.0
5. Peru (1976)					
- No.	2,091	1,346	n.a.	323	3,760
- %	55.6	35.8	n.a.	8.6	100.0
6. Venezuela (1977)					
- No.	2,405	950	109	--	3,464
- %	69.4	27.4	3.2	--	100.0
7. Costa Rica (1981)					
- No.	237	142	32	--	411
- %	57.7	34.5	7.8	--	100.0

* Includes research being carried out in government agencies and public enterprises.

** Includes research being carried out in private enterprises, although the information on the latter is very limited.

1/. The distribution of researchers by institutional sector was estimated for this year on the basis of the percentage distribution for 1974 and the total figures available for 1980.

Source: This information is taken from Table 10 (p. 27) of Fernando Chaparro: 1982 Regional Report: Research in Latin America and the Caribbean and IDRC Programs in the Region; Bogota, IDRC/LARO, 1982.

T A B L E 2

DISTRIBUTION OF RESEARCH EXPENDITURE BY INSTITUTIONAL SECTOR IN A GROUP OF LATIN AMERICAN COUNTRIES

(In thousands of local currency and US$)

Institutional Sector	B R A Z I L (1 9 7 8)			M E X I C O (1 9 7 8)1/			C H I L E (1 9 7 8)		
	Cruzeiros	U.S.$	%	Pesos	U.S.$	%	Pesos	U.S.$	%
1. Universities	5,548,000.0	307,028.2	26.7	1,541,576.4	67,851.1	24.7	423,271.4	11,364.2	17.3
2. Government Research Centres*									
a) Govt. agencies & Research Institutes	8,791,000.0	486,496.9	42.3	3,775,926.0	166,193.9	60.5	n.a.	n.a.	n.a.
b) Public Enterprises	6,442,000.0	356,502.5	31.0	68,653.2	3,021.7	1.1	n.a.	n.a.	n.a.
Sub-Total	15,233.000.0	842,999.4	73.3	3,844,579.2	169,215.6	61.6	1,525,565.2	40,959.2	62.4
3. Private Research Centres	n.a.	n.a.	n.a.	530,502.0	23,349.6	8.5	496,453.3	13,329.0	20.3
4. Others**	--	--	--	324,542.4	14,284.4	5.2	--	--	--
TOTAL	20,781,000.0	1,150,027.6	100.0	6,241,200.0	274,700.7	100.0	2,445,289.9	65,652.4	100.0

* When no disaggregated information is available in terms of the two categories of government research centres, only the sub-total for the whole sector appears in the Table.

** This refers mainly (when available) to the external sector (i.e. international or regional research institutes located in the country).

Source: This information is taken from Fernando Chaparro: 1982 Regional Report: Research in Latin America and the Caribbean and IDRC Programs in the Region; Bogota, IDRC/LARO, 1982.

TABLE 2 (Cont.)

DISTRIBUTION OF RESEARCH EXPENDITURE BY INSTITUTIONAL SECTOR IN A GROUP OF LATIN AMERICAN COUNTRIES

(In thousands of local currency and US$)

Institutional Sector	COLOMBIA (1978)			ECUADOR (1979)			PERU (1976)		
	Pesos	U.S.$	%	Sucres	U.S.$	%	Soles	U.S.$	%
1. Universities	215,034.3	5,500.2	26.7	41,127.1	1,645.1	14.1	348,000.0	6,059.5	12.6
2. Government Research Centres*									
a) Govt. Agencies & Research Institutes	482,417.8	12,339.4	59.9	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
b) Public Enterprises	3,221.5	82.4	0.4	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Sub-Total	485,639.3	12,421.8	60.3	186,463.9	7,458.5	64.2	2,275,000.0	39,613.5	82.3
3. Private Research Centres	104,698.4	2,678.0	13.0	63,072.3	2,522.9	21.7	140,000.0	2,437.7	5.1
4. Others**	--	--	--	--	--	--	--	--	--
TOTAL	805,372.0	20,600.0	100.0	290,663.3	11,626.5	100.0	2,763,000.0	48,110.7	100.0

* When no disaggregated information is available in terms of the two categories of government research centres, only the sub-total for the whole sector appears in the Table.

** This refers mainly (when available) to the external sector (i.e. international or regional research institutes located in the country).

T A B L E 2 (Cont.)

DISTRIBUTION OF RESEARCH EXPENDITURE BY INSTITUTIONAL SECTOR IN A GROUP

LATIN AMERICAN COUNTRIES

(In thousands of local currency and US$)

Institutional Sector	VENEZUELA (1978)			COSTA RICA (1981)		
	Bolivares	U.S.$	%	Colones	U.S.$	%
1. Universities	244.052.7	56.855.6	28.2	37,367.8	2,466.0	47.6
2. Government Research Centres*						
a) Govt. agencies & Research Institutes	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
b) Public Enterprises	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Sub-Total	621,382.3	144,760.0	71.8	33,632.5	2,219.6	42.8
3. Private Research Centres	n.a.	n.a.	n.a.	10,332.7	500.4	9.6
4. Others**	--	--	--	--	--	--
TOTAL	865,435.0	201,615.6	100.0	81,333.0	5,186.0	100.0

* When no disaggregated information is available in terms of the two categories of government the sub-total for the whole sector appears in the Table.

** This refers mainly (when available) to the external sector (i.e. international or regional institutes located in the country).

government research centres constitute the main actors of the research that is being done in these countries (as measured by the volume of financial resources dedicated to research - see Table 2). The predominance of the public sector is particularly notorious in Peru (82.3%), Brazil (73.3%) and Venezuela (71.8%). In Mexico, Chile, Colombia and Ecuador government research centres represent between 60 and 64% of the total research effort, as measured by research expenditure (see Table 2). A different institutional pattern appears in Costa Rica, where both the universities and the government research centres play a major role in research, with even a slight predominance of the former (47.6% and 42.8%).

Private research centres have appeared mainly in two research areas in the region: in commercial agriculture and in the social sciences (for very different reasons). The figures that appear in Table 2 underestimate the importance of the private sector, given the fact that there is almost no information available for the research that is being carried out by the private industrial sector (at the firm level). Nevertheless, the limited information available shows that between 5 and 25% of the research in the region is in the hands of private research centres, depending on the country. This sector is particularly important in Ecuador, Chile and Colombia (see Table 2). Unfortunatelly no information on this is available for Brazil and Venezuela, although such institutes are also important in these two countries.

In the public sector there has been an interesting evolution of the relative importance and the role played by the three types of research units that we are including under the heading "governmental research centres". In an initial stage, government agencies directly engaged in research in areas of interest to them (i.e. Ministries, etc.), as a support activity for their own development programs. When the research activity as such becomes sufficiently important, there has been a tendency to create an autonomous public research institute in that research area. This has mainly happened in agricultural research, health research and industrial technological research. To a more limited extent, research on specific natural resources (i.e. mining, fisheries) and more recently on energy, have given rise to such autonomous public research institutes.

In the last few years another governmental organization has started to play a major role, in certain countries, in research and technological development: this is the public enterprise. Its activities have mainly been identified and studied in Brazil /4. Public enterprises are mainly linked to the productive and service sector (i.e. state oil companies, siderurgical enterprises, petrochemical enterprises, electricity companies, etc.). This, of course, is limited to those countries in which the public sector is important in those production branches.

Areas of Concentration of Research in the Region

The next point to consider is that of the main areas of concentration that characterize the research endeavour in the region. In order to characterize and examine the orientation of research in the region, the following classification of research areas was used (taking into consideration the availability of data):

a) Natural resources (i.e. marine or ocean resources, hydrological resources) and environment.

b) Agriculture, forestry and fisheries.

c) Mining.

d) Industrial technology.

e) Energy.

f) Housing and development of construction technologies and materials.

g) Transportation and telecommunications.

h) Health.

i) Social development (socio-economic development problems and issues).

j) Basic knowledge.

Table 3 summarizes the research profiles of five countries in the region (Brazil, Mexico, Colombia, Venezuela and Costa Rica), in terms of the main research areas that attract the attention of the scientific community (number of researchers per research area), and in terms of the research areas that receive the greatest support from the government and from the research institutions themselves (distribution of research expenditure).

4/. See for example: Fabio Stefano Erber et al: State Enterprises and Technological Development; Ottawa, IDRC-MR24, 1980. And Erno Paulinyi and Celso O. Costa: "O Esforco Tecnologico na Grande Empresa Estatal"; VI Simposio de Pesquisa en Administracao de Ciencia e Tecnologia; Sao Paulo, Universidad de Sao Paulo, 1981.

TABLE 3

MAIN AREAS OF CONCENTRATION OF RESEARCH: DISTRIBUTION OF RESEARCH EXPENDITURE AND RESEARCHERS IN A GROUP OF LATIN AMERICAN COUNTRIES

(Number of physical persons doing research)
(In thousands of local currency and US$)

Research Area	BRAZIL (1978)*			MEXICO (1978)				
	Cruzeiros	U.S.$	%	Pesos	U.S.$	%	No. of Res.** 1980	%**
1. Natural resources and environment	955,926.0	52,901.3	4.6	1,684,100.0	74,124.1	27.0	864	8.3
2. Agriculture, forestry and fisheries	10,037,223.0	555,463.5	48.3				1,749	16.8
3. Mining	748,116.0	41,401.0	3.6	2,060,400.0	90,686.6	33.0	83	0.8
4. Industrial Technology	2,389,815.0	132,253.2	11.5				1,229	11.8
5. Energy	2,244.348.0	124,203.0	10.8	445,500.0	19,608.3	7.1	916	8.8
6. Housing and construction	41,562.0	2,300.1	0.2	534,600.0	23,529.9	8.5	292	2.8
7. Transport and Telecom	415,620.0	23,000.6	2.0				94	0.9
8. Health	1,080,612.0	59,801.5	5.2	734,500.0	32,328.3	11.8	1,302	12.5
9. Social Development	2,119,662.0	117,302.9	10.2	622,500.0	27,398.8	10.0	2,759	26.5
10. Basic Knowledge	748,116.0	41,401.0	3.6	159,600.0	7,024.7	2.6	906	8.7
11. Others	--	--	--	--	--	--	218	2.1
TOTAL	20,781,000.0	1,150.028.1	100.0	6,241,200.7	274,700.0	100.0	10,412	100.0

* The percentage distribution by research area was provided by CNPq for 1981. This percentage distribution was applied to the total research investment for 1978 to arrive at the figures in this column.

** The distribution of researchers by research area was estimated for this year on the basis of the percentage distribution for 1974 and the total figures available for 1980.

Source: This information is taken from Table 13 (pp. 36-38) of Fernando Chaparro: 1982 Regional Report: Research in Latin America and the Caribbean and IDRC Programs in the Region. Bogota, IDRC/LARO, 1982.

TABLE 3 (Cont.)

MAIN AREAS OF CONCENTRATION OF RESEARCH: DISTRIBUTION OF RESEARCH EXPENDITURE AND RESEARCHERS IN A GROUP OF LATIN AMERICAN COUNTRIES
(Number of physical persons doing research)
(In thousands of local currency and US$)

Research Area	COLOMBIA (1978)					VENEZUELA (1977)				
	Pesos	US$	%	No.of Res.	%	Bolivares ***	US$***	%***	No.of Res.	%
1. Natural resources and environment	77,215.0	1,975.0	9.6	335	9.8	49,329.8	11,492.1	5.7	154	4.5
2. Agriculture, forestry and fisheries	359,605.0	9,198.1	44.6	688	20.2	240,590.9	56,049.3	27.8	840	24.2
3. Mining	6,190.0	158.3	0.8	28	0.8	18,174.2	4,233.8	2.1	73	2.1
4. Industrial technology	60,202.0	1,539.9	7.5	472	13.9	79,620.0	18,548.7	9.2	416	12.0
5. Energy	2,199.0	56.3	0.3	31	0.9	14,712.4	3,427.5	1.7	65	1.9
6. Housing and construction	7,962.0	203.6	1.0	79	2.3	20,770.4	4,838.8	2.4	89	2.6
7. Transport and telecom.	15,733.0	402.4	1.9	54	1.6	3,461.7	806.5	0.4	11	0.3
8. Health	127,160.0	3,252.5	15.8	932	27.4	192,126.6	44,758.8	22.2	803	23.2
9. Social development	146,916.0	3,757.9	18.2	762	22.4	102,121.3	23,790.7	11.8	426	12.3
10. Basic knowledge	2,190.0	56.0	0.3	23	0.7	33,752.0	7,863.0	3.9	166	4.8
11. Others	--	--	--	--	--	110,775.7	25,806.8	12.8	421	12.1
TOTAL	805,372.0	20,600.0	100.0	3,404	100.0	865,435.0	201,616.0	100.0	3,464	100.0

*** The distribution of financial resources by research area was estimated on the basis of available data on the number of research projects and the number of researchers existing in each research area.

TABLE 3 (Cont.)

MAIN AREAS OF CONCENTRATION OF RESEARCH: DISTRIBUTION OF RESEARCH EXPENDITURE AND RESEARCHERS IN A GROUP OF LATIN AMERICAN COUNTRIES
(Number of physical persons doing research)
(In thousands of local currency and US$)

Research Area	COSTA RICA (1981)				
	Colones	U.S.$	%	No. of Res.1/	%
1. Natural resources and environment	5,014.0	330.9	6.4	33	8.0
2. Agriculture, forestry and fisheries	35,940.0	2,371.8	45.7	153	37.3
3. Mining	427.2	28.2	0.6	3	0.7
4. Industrial technology	1,608.8	106.2	2.1	10	2.4
5. Energy	4,149.2	273.8	5.3	10	2.4
6. Housing and construction	1,048.6	69.2	1.3	7	1.7
7. Transport and telecom.	159.2	10.5	0.2	1	0.3
8. Health	11,896.0	785.1	15.1	73	17.8
9. Social development	17,841.9	996.0	19.2	100	24.3
10. Basic knowledge	3,247.9	214.3	4.1	21	5.1
11. Others	--	--	--	--	--
TOTAL	81,333.0	5,186.0	100.0	411	100.0

1/. This refers to the number of equivalent full-time researchers.

Some interesting patterns emerge from the analysis of these five profiles. In practically all the countries agricultural research is by far the most important research area in terms of the financial support it receives: 48.3% of research funds goes to agriculture research in Brazil, 44.6% in Colombia and 45.7% in Costa Rica. Venezuela and Mexico give a lower relative importance to this research area. The priority attached to agricultural research in the region reflects the fact that food production still is, and will continue to be, one of the main problems faced by developing countries. But there is an important change that is taking place in the food production problem in the region. The problem is no longer limited to having the peasant grow his own food (for self-consumption or "autosuficiencia"). With a growing percentage of the population in cities, the need of providing food for the huge urban masses that predominate in many Latin American societies is becoming a problem which is as important, if not more important, than the former.

But besides this common denominator two main patterns emerge. Large countries (Brazil and Mexico) give a very high priority to two additional research areas: industrial technology research and research on energy. Brazil spends 11.5% and 10.8% of its total research funds in these two research areas respectively. In the case of Mexico industrial technology and mining (mineral resources) is in fact the largest single research area, with 33% of total research funds. Energy research absorbs 7.1% of the funds available and has been rising sharply (see Table 3). In these large countries health research and social science research occupy a third level of priority in terms of the actual distribution of research funds. In Brazil the relative participation of these two research areas is 5.2% (health) and 10.2% (social development). In Mexico it is 11.8% (health) and 10% (social development).

In the medium and small countries the relationship between these two groups of research areas is exactly the opposite. After agriculture research, the next highest priority goes to health research and to research on social development issues (social sciences), both in terms of the number of researchers that work in those areas and in terms of financial support. Health research represents 15.8% of total research funds in Colombia, 22.2% in Venezuela and 15.1% in Costa Rica. Social science research receives 18.2% of the available research funds in Colombia, 11.8% in Venezuela and 19.2% in Costa Rica.

In this group of countries industrial technology research occupies a third level of priority, with research on energy being in a very initial stage (although on the rise). The proportion of research funds going to industrial technology research is 7.5% for Colombia, 9.2% for Venezuela and 2.1% for Costa Rica. Energy research receives much less attention (see Table 3), although in most countries it is is expected to increase substantially because of the present energy crisis and the role the latter has played in the serious external debt situation that Latin American and Caribbean countries presently face.

A final comment should be made with respect to some of the newer research areas that are starting to appear and receive attention. Many countries of the region are starting to realize that they have given very little attention to applied research on their own natural resources. Specific mention should be made of three non-traditional research areas that are receiving growing attention in the region:

a) Marine or ocean resources.

b) Applied geoscience, related to geological or mining resources.

c) Hydrological resources and integrated environmental management (including pollution problems).

These research areas are receiving growing attention and support from governments in the region, given the potential interest of these topics for the rational utilization of their natural resources.

3. Problems Related to the Identification of Inter-Sectorial Research Priorities for Resource-Allocation Purposes

In the previous section we analyzed two different research patterns or research profiles that characterize the countries of the region, in terms of areas of concentration. It was also pointed out that this tematic concentration of research, or research profiles, do not occur by chance, but that they reflect socio-economic problems or needs of the region, and thus they reflect research priorities. Nevertheless, these inter-sectorial research priorities have been established in a "de facto" way, as a consequence of the "urgency" or the self-evidence of the development problems faced. Only very marginally has it been the consequence of explicit policy or resource-allocation decisions.

The main difficulty of asigning inter-sectorial research priorities is linked to the way national budgets are determined and approved. Most countries of the region have a centralized system for the budget-approval process, based on the Planning Ministry or the Finance

Ministry (or both). It's at this level that funds are allocated to the different sectors of government activity (i.e. education, health, agriculture, defense, industry, etc.). But once the sectorial allocations are made, the further brake-down of the national budget in terms of more specific resource-allocations to concrete programs and activities, is a process that is carried out within each sector (at the intra-sectorial level). Thus the issue seldom comes up, for example, of how much should go to agriculture research, and how much to health research or socio-economic development problems.

The reality of the resource-allocation procedures in national budgets is very different. The question generally comes up at the intra-sectorial level: within the agriculture sector, how much should go to research and how much should go to other agricultural development (or food production) activities (the same is true for the other sectors). Thus the inter-sectorial research priorities are seldom formally considered in this process.

This has led some of the countries of the region (i.e. Brazil and Colombia) to set up a new functional approach (and classification) to their budget approval process. The "functional classification" of the national budget, classifies public expenditure in budget lines that are defined in terms of "functions" of government activities. One of these functions is that of Science and Technology, within which Research and Development is explicitly identified as a sub-function. The objective of this approach is to be able to analyze government expenditure in terms of these functions (in an inter-sectorial perspective), for purposes of resource-allocation.

Thus, in principle, this budget analysis policy instrument is well suited for the purpose of establishing inter-sectorial research priorities. In fact, as pointed out above, certain countries of the region (i.e. Brazil and Colombia) have formally established this budget mechanism with such a purpose in mind. This has been done at the request of the science policy organization (i.e. COLCIENCIAS in Colombia).

Nevertheless, although the functional approach to budget analysis and approval was established in several countries in order to get away from the limitations of the strict sectorial approach, the reality of politics and of the ways governments function, has limited very much the possibility of reaching this objective.

Let's take a specific example. If one believes that the concentration of financial resources is too high in agricultural research and too low in health research, there is no way a re-allocation of resources could be suggested from one to the other. No Minister of Agriculture (or of any other sector) would agree to see part of his sector's resources go to fund health research, no matter how strong a case one may make for the importance (or high priority) of health research in the country. The question is simply irrelevant, in the context of highly sectorialized (and therefore compartimentalized) government departments. If there is any reduction to be made in the funds allocated to agricultural research, the released funds would go to support other agricultural development activities, not other research areas!

The above does not mean that the functional budget classification and the inter-sectorial analysis of resource-allocation to research, has not been useful for research policy purposes and to science policy organizations. They have, but not in the direct way of an "ideal" centralized mechanism for resource-allocation to research, as was the original intention of the planning persons who designed the mechanism. But this budget instrument is starting to be used in three specific ways:

a) It is a valuable source of information that allows governments to keep track and monitor what they are doing in research (what type of research and where, is receiving support from public funds). This information function for monitoring purposes is important.

b) Secondly, although this budget instrument has the above mentioned limitations in terms of a direct instrument of resource-allocation, it may be indirectly used to influence the allocation that takes place within each sector. Coming back to the same example, if the allocation to agricultural research is much higher than that to health research, it is because the Agriculture Ministry is more conscious of the role of research within its sector than the Health Ministry (or the Industry Ministry for Industrial Technological Research). This may or may not reflect the "real need" for research in those different sectors. The science policy organization can use this information to negotiate with those ministries that have a very low allocation to research, an increase in such allocation. From this point of view, the inter-sectorial comparisons of resource-allocation to research in different ministries (through the use of the information provided by the science or research component of the functional national budget), can have a "demonstration effect" in those ministries (or sectors) where research is receiving little attention. Through this indirect way the science policy organization can essentially reach the same objectives that were originally envisaged for this budget policy instrument, despite the fact that a centralized resource-allocation system for research has not worked in practice.

c) Thirdly, most of the countries in the region (certainly the medium and large ones) have "Special Funds" for the support of research, which are not tied to any specific sector (i.e. CNPq in Brazil, COLCIENCIAS in Colombia, CONICET in Argentina, CONACYT in Mexico, etc.). These funds can play a strategic (or balancing) role, in trying to fill-in the gaps (or strengthen the weak areas) that receive little support from the sectorial resource-allocation mechanisms, and that are considered to be of importance for the country. But for this to take place, one needs the information provided by the so-called national science (or research) budget, which is the functional national budget classification.

The observations made in this section, on the basis of some recent Latin American and Caribbean experiences with research policy, clearly show the limitations, but also the functions and possibilities, of inter-sectorial considerations of research priorities. This situation also explains why research and technological development policies have progressively placed more emphasis in the sectorial approach. Research and technological development policies become easier to cope with and more relevant at the level of Sectorial Programs. This is the topic of the next section.

One final comment. One of the problems that some research areas have in mobilizing local support for research (financial resources), is related to the fact that they are not related to any one "sector" of government activity, and therefore they tend to fall in a "no-man's land". The most outstanding case of this is Social Science research in developing countries. Unfortunatelly, many production or service sectors fail to integrate applied social sciences into their own specific sectorial research or development activities. This is partly due to their own lack of awareness of the importance of social science issues or aspects, in their respective sectorial research and development problems. But partly, it is also due to the attitude of some researchers in the social science research community, of not wanting to become involved (or committed) in the efforts of looking for solutions to very specific problems at the sectorial level. Both factors tend to reinforce each other in a vicious circle. When you add to this the fact that there is no specific sector in terms of government activities (and therefore of budgets) that corresponds to social science research in general, with the exception of the higher education (university) sector, the net effect is very little local support in terms of government funds (the situation being very different in the case of agriculture, industrial or health research) /5.

5/. The little receptivity of some governments to social science research (because of political or ideological considerations) is a further aspect that introduces constraints and limitations in those cases.

The problem has become more serious in certain countries, where social science research has "migrated" from the university sector, because of internal instability or political constraints that made it difficult to work within in. Having done so (or having being forced to do so), social science research lost one its "natural basis" and sources of funds at the local level.

One of the countries in Latin America that has very explicitly supported social science research with government funds in the past years (either through grants or through contract research) has been Colombia. Nevertheless, in the last two or three years there has been a deterioration of government support for social science research in this country, which is generating a lot of concern. Besides the general limitations mentioned above, two specific factors are contributing to this (which reflects a situation which is common to other countries of the region). The financial crisis and the cuts in government expenditures is hitting foremost those research areas that do not have a strong sectorial base or sectorial support, thus increasing the "no man's land" phenomena that we mentioned above. Secondly, the increasingly important role played by external credit (i.e. in the case of Colombia large loans for research in specific sectors from I.D.B. and the World Bank, that in turn "tie" counterpart national funds), is involuntarily pushing for a greater sectorial concentration of research funds in certain sectors. This greater degree of "sectorialization" of research funds is "squeezing out" social science research. The vulnerability of the latter to this pressure is partly due to the different factors and characteristics mentioned above /6.

6/. It is interesting to point out that, given the tradition of support to social science research in Colombia, this situation is generating a lot of concern. The "Fundacion para la Educacion Superior" (FES), is spearheading a group of private and government organizations that are coming together, to see what can b done to chang the trend.

4. The Identification of Research Priorities at the Sectorial Level: The Case of Agricultural Research in Colombia 7/.

The identification of research priorities and the allocation of resources on the basis of such priorities, is more feasible at the sectorial level. Section 3 of this paper analyzed some of the main problems involved in assigning inter-sectorial research priorities, and in establishing a resource-allocation system at that level. Given these limitations, most research planning efforts have moved from the global to the sectorial level. Furthermore, it is at this level that research and development activities come together.

In this section we will analyze an outstanding case of sectorial research planning in the region: the case of agricultural research in Colombia. Throughout the seventies up to the early eighties funds allocated to agricultural research in this country had been decreasing in real terms (in constant 1970 values), as well as in the proportion of agricultural GDP that is allocated to research in this sector. Given these circumstances, the Colombian Agricultural Research Institute (ICA) and COLCIENCIAS decided to develop a National Plan for Agricultural Research, as part of a broader effort oriented towards strengthening agricultural research in the country and making it more relevant to the production problems faced in this sector. The presentation of this planning experience is made at three levels:

a) The general methodological framework used in the formulation of the National Plan for Agricultural Research in Colombia (section 4.1).

b) The identification of socio-economic priorities in terms of products or crops (section 4.2).

c) The identification of research priorities in terms of ecologically homogeneous regions and of the farming systems that predominate in them (section 4.3).

4.1 General Methodological Framework

In the Colombian case two major approaches have been attempted in determining agricultural research priorities:

7/. This section is partly based on an article on this experience written by the author and other persons. See F. Chaparro, G. Montes, R. Torres, A. Balcazar and H. Jaramillo: "Research Priorities and Resource Allocation in Agriculture: The Case of Colombia", in D. Daniels and B. Nestel (eds.): Resource Allocation to Agricultural Research, Ottawa, IDRC, 1981, pp.68-96.

a) The first one is crop (or product) oriented.

b) The second one is based more on the concept of farming systems in different ecological zones and the technological constraints they face.

While the first approach is very well suited for the identification of research needs in the commercial agriculture sector, the second one is more practical for the identification of the research needs of small agricultural producers (peasant economies). It is also interesting to point out that while the first approach predominated in the first version of the Agricultural Research Plan that was formulated in 1981, the second approach is a more recent addition that is presently being developed /8.

The first approach (crop-oriented) follows four main steps in the process of determining research priorities:

a) The identification of agricultural products or crops which have a high socio-economic importance or priority for the development of the country.

b) The second step is an attempt of narrowing down this list, by determining which products or crops should receive more support from government funds, and which ones should be left to the initiative (and financial support) of the private sector.

c) The third step involves the identification of the main "technological constraints" or problems that limit production or productivity levels of the different crops under analysis. By "technological constraints" we refer to physiological, environmental or pathological factors, as well as aspects related to management systems and farming practices, that are presently an obstacle for increasing production levels or improving the efficiency of resource-utilization in specific crops or products.

d) The fourth and final step consists in identifying or defining research topics or issues, which are important for the solution of the "technological constraints" that limit production or productivity levels in the crops that have been

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8/. For the first one, see ICA: Plan Nacional de Investigacion Agropecuaria, Bogota, ICA, 1981 (5 volumes). For the second one see G. Urrego, J.H. Tobon, J. Lopera and H. Chaverra: Generacion y Transferencia de Tecnologia Apropiada A Nivel de Finca; Bogota, ICA, December 1984.

selected. It is only in this last step that research priorities as such (expressed in terms of specific research issues), are really formulated.

In section 4.2 of this paper we analyze the methodology that was used in this process, specially the first and the third steps which are the most difficult ones to cope with.

The second approach follows a very similar process, but using a different starting point. While the former places a lot of emphasis on identifying the relative socio-economic priority of different crops, the second approach tackles the problem from the point of view of "ecologically homogeneous zones" (or regions) and of the "farming systems" that predominate in each one. The methodological steps follow a process similar to the one followed by the first approach:

a) The first step is the identification and characterization of the main "ecologically homogeneous zones" (EHZ) that predominate in the agricultural production areas of the country.

b) Secondly, a rapid characterization of the principal farming systems that are found in each EHZ is made. The main objective of this is to identify the main "technological constraints" that limit production or productivity levels in each farming system.

c) Research priorities are formulated in terms of the research topics or issues that may contribute to the solution of such constraints.

Section 4.3 of this paper analyzes these steps in more detail.

4.2 Identification of Socio-Economic Priorities in Terms of Crops and of Their Respective Research Priorities

When setting priorities among products for the allocation of research resources, several fundamental points must be considered:

a) The characteristics of the country's production system, that determines the comparative advantages a country has in producing certain crops (as opposed to importing them in the absence of such advantages). This is related to such aspects as the availability of land, labor, capital and foreign exchange.

b) Aspects related to food security issues must be considered. This refers to the need a country may feel to guarantee the availability of food to meet nutritional needs, or the availability of raw materials to meet industrial production needs.

c) The relative socio-economic importance of the different crops (or agricultural products) being considered, in terms of their role both in the internal and the external market for *agricultural products. This socio-economic importance may be* measured in terms of such variables as:

1) Production parameters:

- Participation in the internal market.
- Participation in the value of exports.
- Participation in the value of imports (representing a potential for import substitution).

2) Rural employment generated by the production of that crop or agricultural product.

3) Area of land dedicated to that crop's production.

4) Relative importance of certain crops for low-income groups or for certain peasant communities.

d) Finally, it should be pointed out that the development model (and macroeconomic policies) followed by the government is an important component of the context within which the relative importance of the previously mentioned factors should be judged. Such policies may assign different roles to the agricultural sector (i.e. increase availability of internal food supply, substitute imports, increase domestic savings, generate foreign exchange through exports, etc.). The existence of such policies may place greater emphasis n one or another of the previously mentioned factors. They may, for example, place more emphasis on food security aspects, r on the role of the export sector (given the need to generate foreign exchange). One may or may not agree with such macro-economic policies, but they certainly influence the criteria with which the relative priority of crops has to be judged.

In the Colombian planning experience two models were used to estimate the relative socio-economic (and thus research) priority of crops. One took into consideration the first two factors mentioned above (comparative advantages and food security), and the other basically concentrated on the third factor (participation in the internal and external markets as indicators of socio-economic importance). We will briefly discuss both of them.

a) Comparative Advantages and Food Security /9.

In developing countries it has been found that when governments establish the price of goods and factors without taking into account the country's endowment of factors, the patterns of technological change that emerge are not compatible with the country's comparative advantages. In many developing countries, government policies undervalue certain kinds of products and overvalue others; the result is that errors are made in allocating resources for production.

In the case of open economies, in which the generation of foreign exchange through exports is an important factor, decisions should not only be taken on the basis of aspects related to domestic agriculture. The concept of comparative advantages becomes relevant, in order to evaluate efficiency or inefficiency in the allocation of resources. For example, in an open economy it may not always be desirable for a country to produce all its own foodstuffs, if some of this food could be acquired more cheaply in international markets. From this point of view, it becomes important to consider such aspects as international prices and the social cost of the domestic resources needed to produce those products (this refers to the opportunity cost of capital, labor, land and foreign exchange).

A country may decide to ignore these considerations for political or social reasons. Two main objections have been raised against the comparative advantages argument. First, the country may not want to take the risks of not being able to import necessary foodstuffs in the future (due to the lack of foreign exchange or due to political constraints). Secondly, from the point of view of social development it may consider it necessary to guarantee an internal supply of basic foodstuffs that are important in the diet of low-income groups. The social costs would be too high if this cannot be guaranteed. These considerations introduce a second criteria to be considered: that of "food security" (or guaranteed food supply).

In the Colombian planning experience a simple model was developed that tried to combine both criteria. The comparative advantage was

9/. This model was developed by Gabriel Montes in Colombia. For a more detailed description of it, see F. Chaparro, G. Montes, R. Torres, A. Balcazar and H. Jaramillo: op. cit., specially pp. 80-84.

estimated by calculating the cost of the domestic resources needed for the production of each crop /10. The food security (or social) importance of each crop was measured by the weight (participation rate) that each product or crop has in the family budget of low-income groups (that is, its weight in the "canasta de consumo" or the consumer's shopping basket). This is an indicator of its importance in terms of the food supply that has to be guaranteed in the country. This second criteria was considered important, given the fact that the National Development Plan of the country placed great emphasis on generating a sufficient supply of food for the adequate nutrition of people, as well as on providing sufficient raw materials for agro-industry.

On the basis of these two criteria it is possible to set up a table or matrix of priorities. Comparative advantage will run along the horizontal axis and the importance a product has in family spending (food security aspect) runs along the vertical axis (see Figure 1). The combination of these two criteria defines an analytical matrix with four quadrants (see Figure 1). The products in quadrants I and IV of this figure are those in which the country has a comparative advantage, and can export or substitute for imports efficiently. The products in quadrant IV, due to their low position in family spending, are the easiest to export, so quadrant IV contains exportable items. The products in quadrant I make up a significant part of the consumer shopping basket, besides the comparative advantage the country has in their production. Therefore, quadrant I contains products which could efficiently substitute for imports or could be potentially exported. The products in quadrant II, on the other hand, have no comparative advantage but make up a significant part of the consumer shopping basket. The social return on the resources invested in promoting their production is low; this also holds true for the products in quadrant III, whose share of family spending is low. The products in quadrant II are importable or potentially importable. Quadrant III shows importable and domestic products whose share of family spending is not high.

The highest research priority should be given to the products in quadrant I, since they have both a comparative advantage and they are key items in the consumer shopping basket. The products in quadrant III have the lowest priority (they are low in terms of both criteria). Government policy definition would provide the information necessary to establish the difference between quadrants II and IV. If the government decides to adopt a policy of promoting exports and

10/. For a description of the methodology used in calculating the cost of domestic resources, as well as the comparative advantage to produce certain crops, see F. Chaparro, G. Montes, R. Torres, A. Balcazar and H. Jaramillo: op. cit., pp. 80-84.

Figure 1

Table of Priorities of Agricultural Products Using Comparative Advantage and Food Security Criteria*

Importance in Family Budget	Comparative Advantage: Low	Comparative Advantage: High
High	Milk (5.94) Bread (wheat) (3.27) Maize (1.49) Barley Quadrant II (Food self-sufficiency policy)	Beef Cattle (9.86) Potatoes (4.55) Rice (3.57) Vegetable Oil (soya, palm, cottonseed, sesame (3.05) sugar loaf (2.01) eggs (1.80) cocoa (1.71) Quadrant I (High priority)
Low	Fruit (1.21) Pasta (wheat) (1.09) Beans and Lentils (0.80) Peas (0.80) Plantain (0.74) Cassava (0.61) Oats (0.25) Quadrant III (Low priority)	Cotton Bananas (1.24) Coffee (1.19) Sugar (1.01) Tobacco Flowers Quadrant IV (Policy of promoting exports)

0

* The participation or share in the total family budget is shown in parenthesis and represents the structure of spending for blue collar workers in the city of Bogota. For the time being, comparative advantages are positioned subjectively and will remain so until the corresponding calculations have been done.

Note: Comparative advantate is measured along the horizontal axis (from low to high). Food security importance (importance in family budgets) is measured along the vertical axis (from low to high). The combination of both criteria defines an analytical matrix with four quadrants.

Source: Taken from F. Chaparro, G. Montes, R. Torres, A. Balcazar and H Jaramillo: "Research Priorities and Resource Allocation in Agricultur The Case of Colombia"; in Douglas Daniels and Barry Nestel: Resource Allocation to Agricutural Research; Ottawa, IDRC, 1981, Figure 2, p. 83.

obtaining foreign exchange to provide guaranteed supplies of food, quadrant IV would be favored. However, if the government adopts a food self-sufficiency policy, quadrant II is favored. Exporter countries adopting the first type of policy would prefer quadrants I and IV, while self-sufficient countries would choose quadrants I and II.

Furthermore, we must also determined which products should receive priority government financing, and which ones should be left to the initiative of the private sector. This is done by examining the price elasticity of demand. When the demand for a product is inelastic, consumers reap the benefits of research; when the demand is elastic, it is producers who benefit from research. Therefore, the gov rnment should finance research on priority products having the least price elasticity of demand and continue up the scale until available resources are exhausted. The research on the other products should be financed by the private sector. Since exportable products usually have a high price elasticity of demand, the products in quadrant IV would be financed by the private sector (coffee, sugar cane, cotton, etc.), whereas the government should handle the products in quadrants I and II.

This decision-making model is easy to set up and use. Its main limitation is that it requires relatively sophisticated information, if it is applied rigurously. It requires at least two sets of data. First, information on family budget spending derived from the consumer's shopping basket. Secondly, it requires the calculation of the domestic opportunity cost of the resources used in agricultural production, as well as of the shadow exchange rate. While the first type of information is generally available in developing countries, the second one does involve more information gathering and analysis. Nevertheless, this analytical model can be applied in a more subjetive way, by subjectively classifying crops or agricultural products in terms of the country having a "high" or a "low" comparative advantage in producing them. This can be done reasonably well by a panel f persons who know the country's economy and agricultural sector very well. In fact, that was the way it was done in the Colombian experience, in the absence of more sophisticated data. In this way, the heuristic value of this decision-making model is quite high in terms of defining policy options, and in terms of relating crops and agricultural products to the different policy options.

Having set product priorities at the economic level, the planning process went on to identify "technological constraints" that limit their production or productivity level, and the research priorities that are derived from the latter.

b) Socio-Economic Importance of Crops in Terms of the Internal and External Markets for Agricultural Production /11.

Two of the main functions that have been assigned to the agricultural sector in the economic development process is that of the satisfaction of the internal demand for food and raw materials, on the one hand, and the generation of foreign exchange needed to sustain the development of the national production system, on the other. The capacity of the agricultural sector to carry out these two functions depends, to a large extent, on the magnitude of the Gross Agricultural Product generated by this sector. It is for this reason that one of the most common indicators to measure the relative importance of every agricultural product, has been the participation of that crop or product in the total value of agricultural production.

Nevertheless, in order to take into consideration the different functions that have been assigned to the agricultural sector, a more appropriate indicator appears to be the total value generated by the circulation of agricultural products in a given economy, which we will refer to as the total value of agricultural circulation.

The total value of agricultural circulation is defined as the sum of the value generated by the three markets of agricultural products: (a) agricultural production for the internal market, (b) agricultural exports, and (c) agricultural imports. The socio-economic importance or priority of each crop or agricultural product, is determined by the relative participation of each one in the total value of agricultural circulation.

The methodology that was developed to calculate this index basically consists in a weighted average of the participation of each crop in the three types of agricultural markets. That is, a crop's participation in agricultural exports (or imports) is weighted by the importance of agricultural exports (or imports) in the total food market of the country. It should be pointed out that normally any given crop appears only in two of these three markets, since it is only under very special circumstances that the same crop is both exported and imported in a specific country.

In order to avoid the distorsions introduced by exceptionally high exports or imports in any given year, the average annual values over a number of years was used (for each crop).

11/. The approach presented in this section was developed by Ricardo Torres and Alvaro Balcazar. For a more detailed description of it, see F. Chaparro, G. Montes, R. Torres, A. Balcazar and H. Jaramillo: op. cit., specially pp. 84-89.

Table 4 shows the results of evaluating the relative importance of 28 crops and agricultural products in Colombia, using this indicator (for a more detailed description of how the index that appears in Table 4 was calculated, see the article that appears in footnote 11).

For comparative purposes, Table 4 also includes information on the participation rates of the different crops and products in the total value of agricultural production for this same period (see first column of Table 4). By comparing the first and the last columns of Table 4 we can compare the priority rankings that are established by using the two alternative indicators: participation in total value of agricultural production (first column) and participation in total value of agricultural circulation (last column).

The final outcome of this process was that of dividing the different crops or products in terms of the four broad categories or groups that appear in Table 4, in terms of their priority ranking.

Since the variables that were used in this process are basically production variables, two additional indicators were taken into account: rural employment generated by each crop and the extension of land (area) under that crop's production. No significant modification in the priority ranking of products was introduced by these two additional variables. Thus the participation in the total value of agricultural circulation would seem to be a reliable indicator of socio-economic importance.

c) The Identification of Technological Constraints and Research Priorities Within Selected Crops or Agricultural Products

Besides establishing the relative importance or socio-economic priority of the different crops and agricultural products, the other main component in the overall process of research planning in this sector is that of identifying the main "technological constraints" that have a negative impact on the production or productivity levels of the different crops under consideration, and of the research topics or issues that should be carried out in order to cope with those problems.

In order to do this, it was first necessary to identify the principal technological factors that intervene in the production process, both in the case of crops and in the case of animal production. In the case of crops, the principal technological factors were conceived in terms of eight categories, each one related to a specific discipline of the agronomy sciences, as follows:

Table 4

Weighted Participation Coefficients of Main Products in Total Value of Agricultural Circulation and Computation of General Priority Index

	Product	Participation Agr. Produc. Value 1972-76	PARTICIPATION IN: Domestic Market %	Exports %	Imports %	WEIGHTED PARTICIPATION IN: Domestic Market %	Exports %	Imports %	General Priority Index
Group 1	Coffee	15.8	5.0	73.3	-	3.58	18.54	-	22.12
	Beef Cattle*	13.9	15.5	4.7	0.1	11.10	1.19	-	12.29
	Dairy Cattle	8.9	10.5	-	2.3	7.52	-	0.07	7.59
Group 2	Cotton	4.9	5.1	6.2	-	3.65	1.57	-	5.22
	Rice	5.9	6.8	0.8	-	4.87	0.20	-	5.07
	Cassava	5.7	6.7	-	-	4.80	-	-	4.80
	Pigs	5.1	6.0	-	-	4.30	-	-	4.30
Group 3	Plantain	4.5	5.2	-	-	3.72	-	-	3.72
	Sugar Cane	3.2	3.1	5.8	-	2.22	1.47	-	3.69
	Poultry Meat	4.3	5.0	-	0.8	3.58	-	0.02	3.60
	"Panela" (sugar loaf)	4.3	5.0	-	-	3.58	-	-	3.58
	Eggs	4.0	4.7	-	-	3.36	-	-	3.36
	Maize	3.6	4.2	-	3.5	3.01	-	0.11	3.12
	Potatoe	3.5	4.0	-	-	2.86	-	-	2.86
Group 4	Wheat	0.3	0.4	-	52.0	0.29	-	1.61	1.90
	Bananas	1.9	1.2	2.8	-	0.86	0.71	-	1.57
	Sorghum	1.3	1.5	-	-	1.07	-	-	1.07
	Beans	1.2	1.2	0.6	0.2	0.86	0.15	-	1.01
	Tobacco	0.9	0.7	1.9	-	0.50	0.48	-	0.98
	Soybean	0.8	0.9	-	6.4**	0.64	-	0.20	0.84
	Cocoa	0.7	0.8	-	6.9	0.57	-	0.21	0.78
	African Palm	0.7	0.8	-	-	0.57	-	-	0.57
	Barley	0.5	0.5	-	4.2	0.36	-	0.13	0.49
	Yam	0.3	0.3	-	-	0.21	-	-	0.21
	Sesame	0.2	0.3	-	-	0.21	-	-	0.21
	Oats	-	-	-	2.4	-	-	0.07	0.07
	Sheep	-	0.1	-	-	0.07	-	-	0.07
	Peanuts	-	-	-	-	-	-	-	-
Relative Importance of Components of Agric. Circulation			71.6	25.3	3.1				

*Include' 'ive bovines **Incl' 's Soybean Oil

Source: ..ken from F. Chaparro, G. Montes, R. Torres, A. L..cázar and H. Jaramillo: op. cit., Table 15, p.88

Technogical Factors	Disciplines
1) Farming practices (including cropping systems).	1) Farming practices.
2) Production equipment: agricultural machinery and implements.	2) Agricultural machinery.
3) Knowledge on plant genetics, and on the development of desirable genotypes and their seeds.	3) Plant genetic improvement.
4) Knowledge on insects, rodents and moluscs, on their impact in crops, and on control methods.	4) Entomology.
5) Knowledge on plant diseases, on disease-causing agents (bacteria, virus, fungi) and on their control.	5) Plant pathology.
6) Knowledge on plant physiology, in order to improve their efficiency (yield) or to control them (weeds).	6) Plant physiology.
7) Soil as a factor of production: knowledge on soils: their characteristics, improvement and conservation.	7) Soil sciences.
8) Water as a factor of production: knowledge on hydrological resources and on water management and distribution (irrigation).	8) Water and irrigation.

In the case of animal production, the following six technological factors (and disciplines) were considered:

Technological Factors	Disciplines
1) Knowledge on animal production systems and techniques.	1) Animal production.
2) Knowledge on animal physiology and reproduction.	2) Animal physiology and reproduction.
3) Knowledge on animal genetics and on cross breeding.	3) Animal genetics.
4) Animal food and feeding systems; nutrition problems.	4) Animal food and nutrition.
5) Pasture and forage as a factor of production.	5) Pasture and forage.
6) Knowledge on animal diseases, their causes and their control.	6) Animal health.

One important aspect that has to be considered is that the technological constraints for a given crop can vary from one ecological region or zone of the country to another (i.e. depending on the region, the main technological constraint faced by that crop may be soil defficiency problems, or it may show specially low yields or particularly high vulnerability to certain diseases). Thus the analysis of technological constraints is both product-specific and region-specific, although some of them may cut across several regions.

This analysis of the technological constraints that each crop (or product) faces in the different ecological regions of the country was carried out in working groups or panels, in which both researchers and producers acquainted with that crop participated (basically using the delphic technique) /12. The different working groups were established along crop (or product) lines, given the fact that the overall exercise was very much crop-oriented.

The discussion of the working groups as such centered around two main issues:

a) Analysis of the real importance and nature of each of the technological constraints that the crop confronts in the different ecological regions.

b) Identification of the research topics that should be tackled, in order to generate the knowledge or know-how that is needed for the solution of those problems. In certain cases, the problem may not be one of research, but of simple technical assistance or extension services that have to be provided to the producers.

The outcome of this process was the formulation of a set of research topics (or priorities) that should be tackled in the case of each crop (or agricultural product), aimed at solving or controlling the principal technological constraints that were identified with respect to that product. This is the content of the National Research Programs that were formulated for each crop.

12/. The use of the Delphi methodology and of matrix techniques in this type of analysis is not new. See, for example, Marvin J. Cetron and Bodo Bartocha: The Methodology of Technology Assessment; New York, Gordon and Breach Science Publishers, 1972.

4.3 Identification of Research Priorities in Terms of Ecologically Homogeneous Regions and of the Farming Systems that Predominate in Them

In the previous section we analyzed the approach that was used in the first version of the National Plan of Agricultural Research (1981). More recently, ICA has complemented this first version of the agricultural research plan with a second approach aimed at filling in the gaps of the previous one.

The analysis of these gaps are interesting. While the first approach was very good in terms of establishing socio-economic and research priorities among the different crops and agricultural products, and in identifying the production (and therefore research) problems they confront, this approach had three specific weaknesses:

a) The first approach is better suited to find research problems that are more relevant for the commercial agriculture sector (where monoculture predominates), than for the small producers and for the peasant economy sector.

b) Secondly, it considers the production problems (or technological constraints) of specific crops in isolation from one another, and not in the context of the farming systems in which they are quite often located and produced. This problem is irrelevant under conditions of monoculture; but it is a limitation when that is not the case. Some of the technological constraints that limit the production or productivity levels of those crops, cannot be analyzed properly if it is not within the context of the farming systems in which they grow. This is one of the reasons for the first weakness mentioned above. But farming systems are not only used by small producers; they cut across different types of producers.

c) Since the emphasis is placed on crop-oriented programs, the first approach is not very sensitive to specific regional needs, in the different regions of the country. Although it uses the concept of "ecologically homogenous regions (or zones)", the latter is used as an "intermediate" variable in order to identify region-specific technological constraints of the respective crops. It does not put the emphasis on regional needs.

The second approach that ICA is presently using as a complement to the first one, is precisely aimed at filling in these gaps. Thus it takes as a point of departure a regional approach, instead of a crop approach /13. In order to do so, the country was divided into eight "natural regions" (which is the regional structure that ICA has for its normal operations). In turn each region was subdivided into "ecologically homogenous zones" (or sub-regions). These sub-regions were identified and defined by combining two sets of characteristics: physical parameters (i.e. climatic variables, water availability, types of soil and dominant flora and fauna), as well as socio-economic parameters (i.e. land tenure structure, type of producer, agricultural population, etc.).

While in the first approach the regional context was taken into consideration only for the purpose of defining region-specific technological constraints that limit the production or productivity levels of certain crops, this second approach concentrates its analysis on the regional context as such, without taking a crop perspective.

Having identified the main ecologically homogeneous regions (or sub-regions) that make up the agricultural area of the country, the planning and execution process that is presently being set up has three main steps:

a) The selection of those ecologically homogeneous regions in which ICA's research effort should concentrate /14. Several criteria are being used in this selection process: importance in terms of agricultural production; the presence of certain "target populations" that are considered high priority; the potential of that sub-region in terms of future development; the extent to which it is "representative" of ecological and socio-economic characteristics that are common in other parts of the country (in order to facilitate diffusion of results); and the existence of a research or experimental station (of ICA) that may service that sub-region. Subregions are being selected in such a way as to cover small, medium and large producers, in order to have a cross-representation of the different types of users or clients that ICA has.

13/. For a description of the approach that is being used, see G. Urrego, J.H. Tobon, J. Lopera and H. Chaverra: Generacion y Transferencia de Tecnologia Apropiada a Nivel de Finca; Bogota, ICA, December of 1984. On the methodological aspects of this approach also see Hernan Chaverra: El Enfoque de Sistemas y la Identificacion de Prioridades de Investigacion Agricola; Lima, INIPA/IICA, 1983.

14/. It is interesting to point out that "priorities" are here expressed not in terms of crops or agricultural products, but in terms of what regions or sub-regions should receive priority attention.

b) A characterization of the agricultural production system of the different sub-regions is then carried out (this and the previous step can be carried out simultaneously). This involves the identification and analysis of the principal agricultural products in that sub-region (both in terms of crops and animal production), as well as of the principal farming systems or cropping systems that are being used. A rapid review of the support services that exist in the regi n or sub-region (i.e. technical assistance programs, credit facilities, marketing facilities, etc.) is also done, since they have a direct impact on the rural development possibilities of that region.

c) Thirdly, in those sub-regions selected for concentration of effort, very rapid surveys are done in order to identify the "technological constraints" that have a negative impact on the production or productivity levels of the farming systems that predominante in them. Several agricultural research institutes have developed different methodologies for these "quick surveys" that have to be carried out at this micro-regional level, in order to identify the technological constraints of the existing farming systems, which defines the research priorities for that specific sub-region (see the experiences of ICA, CIMMYT, CATIE, CIP, CIAT and others). There is presently an ongoing effort of systematizing and integrating these different approaches, to what essentially is the same problem.

Since this second approach to agricultural research priorities is only presently being developed, it is not yet as systematized as the first one. Furthermore, these two approaches are not mutually exclusive. It is not a matter of deciding to take a pure crop perspective or a pure regional perspective. Both approaches are useful and, if combined, as ICA is doing it, it gives a broad view of research needs in a country.

Each approach is well suited for identifying different types of research needs. The first one is able to provide orientation to the crops-oriented research programs that ICA, and most agricultural research centres, have. In a certain sense, the first approach is a corollary of the predominant organizational structure that most agricultural research institutes have in the region (organized in terms of crops-oriented programs). In terms of this program structure, the first approach is very functional.

The interesting aspect of the second approach is that it not only takes a new look at agricultural research priorities, but it also presents a different perspective of the way agricultural research can be organized /15. Furthermore, given its emphasis on the regional dimension, it is able to highlight certain aspects that the crop approach overlooks. (a) It is interesting to point out that the relative priority of certain crops changes, when you look at it from the national point of view (first approach) or from the regional perspective (second approach). Certain crops may be very important in some specific regions, although in terms of national priorities they come out low. The second approach is better suited for the identification of these regional priorities (in terms of crops) /16. (b) Secondly, this approach integrates the farming systems perspective into research planning. It is thus able to identify certain research problems that the other one overlooks, and it is better suited to identify the research needs of the small producer. (c) A third interesting characteristic is that this approach provides a closer link between research programs and rural development activities, at the level of each specific sub-region. In analyzing the socio-economic characteristics of each sub-region, it looks into the characteristics of the target population with whom it is working, and into the services (i.e. marketing, credit, etc.) that exists in that region. Thus the emphasis that it places on the regional context of research activities and on regional development, does promote a more integrated view of rural development problems, leading to a closer link between research and other rural development activities in each specific region (i.e. credit facilities, transportation, cooperative arrangements, education, etc.).

15/. In fact, this second approach is part of a broader effort that ICA is doing of reconsidering its own organizational and program structure. On this, see Jorge Ardila: "Bases para el Plan de Trabajo de la Subgerencia de Investigacion y Transferencia de Tecnologia Agropecuaria"; Bogota, ICA, July 1984.

16/. This raises the question of when (or under what circumstances) should regional priorities receive recognition as a national priority. In Colombia a certain division of labor is being established between ICA and some of the provincial universities. When a crop can be considered to have "national importance" it is the responsibility of ICA to carry out research on it. When a crop is important only in very specific regions, and not in terms of national standards, research on it becomes the responsibility of provincial universities or of other research centres located in that province.

5. Some Weaknesses in the Process of Planning and of Resource-Allocation for Development Research

The process of research planning and of resource-allocation in this area has faced a series of limitations in Latin American and Caribbean countries. Among these, the following should be mentioned:

a) Rigidities in the resource-allocation system.

b) Limited capacity in the research centres of developing countries for a continuous evaluation of research programs (research evaluation).

c) Lack of relevant data for decision-making and for the monitoring of research programs. This is not only an information problem. It is also one of developing appropriate indicators of research impact or of scientific and technological development.

d) Weaknesses in the link between research and development activities.

We will only make a brief comment on each of these weaknesses.

The first limitation refers to the fact that the research planning process is an activity that is not carried out in the vacuum. It often confronts institutional cleavages and discontinuities that exist between different sectors of government action, and that may introduce rigidities in the resource-allocation process. Section 3 of this paper pointed out one of the main rigidities in resource-allocation to research, in analyzing the problems related to the identification of inter-sectorial research priorities. Similar rigidities may exist (although to a lesser extent) in allocating resources to different research institutes within the same sector. Given these rigidities that are introduced by the existing organizational structure of research and/or of the government sector, resources are not always allocated on purely rational grounds on the basis of priorities. Even within the same institution, where presumably one would have the greatest degree of freedom in allocating resources according to rational priorities, the existing research program structure is a factor that has to be taken into consideration. Priorities have to be implemented through organizations, but organizational structures are not always amenable to quick changes. This problem has been extensively analyzed in the literature on formal organizations, among which research institutes are no exception.

The second limitation mentioned above refers to one of the bottlenecks that exists in developing countries: there is a very limited capacity for a continuous process of evaluation of research programs. Research evaluation plays an important role both in research planning and in research management.

It provides valuable feedback both to the planner and the manager, in terms of the actual performance and impact of ongoing programs. Both for research planning and research management this is an important element of information, since in both cases we are concerned with the improvement of existing research efforts, and with strengthening the link between research and actual development activities. Research evaluation, carried out on a continuous basis, may provide a valuable input for both objectives.

Only recently agricultural research institutes (as well as governments) around the region are starting to get interested on how to set up (or improve, if they exist) evaluation mechanisms for their research programs. When we speak of "research evaluation" we refer to at least three different levels of evaluation:

a) Technical evaluation: this is the evaluation of a research program (or project) in terms of the degree to which it has achieved the technical or scientific objectives of the research. Among other things, depending on the type of research, this first level of research evaluation has to determine to what extent the research results have produced specific innovations or technologies that may be useful to potential users.

b) Evaluation of the degree of dissemination of the technologies developed: this carries the evaluation process one step further, in determining the extent to which the innovations, information or technologies produced by research, are in fact being used by the producers or other type of potential users. If the are not, why not? What other factors hav to be considered or integrated into the process, in order to increase the feasibility or likelihood that the research results may be translated into concrete innovations? It is at this level that research often has to be linked to other development activities, such as technical assistance and credit, before the results can really be adopted and used. Research evaluation helps to identify these bottlenecks and to promote these links. This is the type of feedback that is useful.for the research planner and for the research manager.

c) Development-impact evaluation: the third level of research evaluation is the one that is most difficult to cope with. It implies not only determining the actual degree of dissemination or use of the technologies or innovations

> developed (second level), but also the extent to which the adoption of these innovations are generating some type of socio-economic benefits, and for whom. It is only at this level that we are able to assess (evaluation may not be the best word) the socio-economic impact of research. In the case of development-oriented research, this third level of evaluation is paramount. Again, it produces feedback information that is basic for the research planner and the research manager, in identifying the need to reorient certain programs or strengthen others.

Many governments or agricultural research institutes in the region have already established some type of evaluation mechanism of their research efforts. But quite often they only pay lip-service to it, or they take it as a formality that has to be "complied with". Not as a dynamic mechanism that, if well utilized, may provide very useful information not only to the research planner and the research manager, but also to the researcher himself.

Several factors have limited the development of research evaluation in the region. First, traditionally there has been more emphasis placed on the formulation of priorities and on the development of research programs and projects, than on their monitoring and continuous evaluation. Secondly, there is a lack of evaluation methodologies or techniques for research projects (or programs). Project evaluation methodologies have been mainly aimed at "ex-ante" evaluation (i.e. to judge whether a project is good or bad, in order to accept it or reject it). It is quite clear that we are referring here to "ex-post" research evalution, where the development of methodologies has been much weaker. Futhermore, if such methodologies are to be utilized on a continuous basis, they have to be relatively simple, and not require an exorbitant amount of information. Thirdly, there is a lack of trained manpower on this topic in developing countries. This is aggravated by the fact that since many research institutions take only a very formal (and superficial) approach to research evaluation, they do not dedicate their best human resources to such a marginal activity. As a corollary to this, the technical staff of research institutes mis-trust the process, looking at it as a "control mechanism" that interferes with their work.

The third weakness that the research planning process confronts in the region is the lack of relevant data for decision-making and for the monitoring (and evaluation) of research programs. This is a problem faced both by research planning and research management /17.

This is not only an information problem per se; it is also one of developing appropriate indicators of scientific and technological activities, of the efficiency of research programs, of technological innovation and technological change, and of development-impact. Annex III of this paper presents some general reflections on the topic of science and technology indicators.

The fourth weakness mentioned above, related to the link between research and development, has been marginally touched upon in some of the preceeding sections. A more detailed analysis of it would take us beyond the scope of this paper.

17/. The National Agricultural Research Institute (INIA) of Mexco has set up an interesting "management information system", aimed at providing the institute's management with continuous information on the orientation and performance of their research programs. This case has been analyzed in a report by Basilio Rojas: Sistemas de Informacion para la Administracion de Investigaciones Agricolas; Bogota, IDRC, May 1983.

A N N E X E S

ANNEX I

SCIENCE POLICY ORGANIZATIONS IN LATIN AMERICA AND THE CARIBBEAN

1. National Councils for Science and Technology

Country:	Organization:	Established:
Argentina	Secretaria de Estado de Ciencia y Tecnologia.	1968
Brazil	Conselho Nacional de Desenvolvimento Cientifico e Tecnologico (CNPq)	1951
Barbados	National Council of Science and Technology.	1977
Colombia	Fondo Colombiano de Investigaciones Cientificas y Proyectos Especiales (COLCIENCIAS).	1968
Costa Rica	Consejo Nacional de Investigaciones Cientificas y Tecnologicas (CONICIT)	1972
Chile	Consejo Nacional de Investigacion Cientifica y Tecnologica (CONICYT).	1967
Ecuador	Consejo Nacional de Ciencia y Tecnologia (CONACYT).	1981
Mexico	Consejo Nacional de Ciencia y Tecnologia (CONACYT).	1970
Peru	Consejo Nacional de Ciencia y Tecnologia (CONCYTEC).	1968
Trinidad y Tobago	National Council for Technology in Development.	1977
Uruguay	Consejo Nacional de Investigaciones Cientificas y Tecnicas (CONICYT).	1961
Venezuela	Consejo Nacional de Investigaciones Cientificas y Tecnologicas (CONICYT).	1968

A N N E X I (Cont.)

2. Divisions or Offices Within National Planning Agencies

Country:	Organization:	Established:
Costa Rica	Unidad de Ciencia y Tecnologia; Oficina de Planificacion Nacional y Politica Economica (OFIPLAN).	1979
Dominican Republic	Unidad de Ciencia y Tecnologia, Secretariado Tecnico de la Presidencia.	1974
El Salvador	Departamento de Ciencia ty Tecnologia; Ministerio de Planificacion.	1974
Guatemala	Unidad de Ciencia y Tecnologia; Secretaria General del Consejo Nacional de Planificacion Economica.	1974
Honduras	Departamento de Ciencia y Tecnologia; Consejo Superior de Planificacion Economica.	1975
Jamaica	Office of Science and Technology; National Planning Agency.	1976
Panama	Departamento de Ciencia y Tecnologia; Ministerio de Planificacion y Politica Economica.	1975

A N N E X II

EXAMPLES OF SECTORIAL RESEARCH AND DEVELOPMENT PROGRAMS IN LATIN AMERICAN AND CARIBBEAN COUNTRIES

The list presented in this Annex is by no means exhaustive; it is intended only to illustrate the type of sectorial research planning efforts that have been carried out in the region. The documents that are mentioned in this Annex are in themselves a valuable source of information on research issues that are of interest to these countries in the different sectors they cover, and of information on what the scientific community in the region is working on. Some of these sectorial programs are more related to research as such; others are more of a technological development nature; a few combine both aspects. The list is classified by country:

A) COLOMBIA:

1) COLCIENCIAS: Situacion Actual y Perspectivas Futuras de las Ciencias del Mar en Colombia (Present Situation and Outlook of Marine Sciences in Colombia); Bogota, COLCIENCIAS, 1978.

2) COLCIENCIAS, C.C.O. and D.N.P.; Plan de Desarrollo de las Ciencias y las Tecnologias del Mar en Colombia (Development Plan for Marine Sciences and Technology in Colombia); Bogota, COLCIENCIAS , 1980.

3) I.C.A.: Plan Nacional de Investigaciones Agropecuarias (National Agricultural Research Plan); Bogota, ICA, 1981 (5 volumes).

4) COLCIENCIAS/I.I.T.: Programa Nacional de Investigacion y Desarrollo Tecnologico en Alimentos y Nutricion (National Research and Technological Development Program in Food and Nutrition); Bogota, COLCIENCIAS, 1983.

5) CONIF: Plan Nacional de Investigaciones Forestales (National Forestry Research Plan); Bogota, CONIF, 1984 (2 volumes).

6) COLCIENCIAS: Programa Nacional de Desarrollo Tecnologico para el Sector Industrial (National Program for Technological Development in the Industrial Sector); Bogota, COLCIENCIAS, 1983.

7) COLCIENCIAS: Programa Nacional de Ciencia y Tecnologia en Recursos Energeticos (National Science and Technology Program in Energy Resources); Bogota, COLCIENCIAS, 1984.

ANNEX II (Cont.)

8) COLCIENCIAS: Programa de Desarrollo Tecnologico en Electronica y Telecomunicaciones (Technological Development Program in Electronics and Telecommunications); Bogota, COLCIENCIAS, 1984.

9) Rodrigo Losada: Bases para un Plan de Concertacion Nacional en Ciencias Sociales e Historia (Basis for a National Program on Social Sciences and History); Bogota, COLCIENCIAS, 1984.

10) Luis Fernando Duque: La Investigacion en el Sector Salud (Research in the Health Sector); Bogota, Instituto Nacional de Salud (I.N.S.), Oct. 1983.

11) Beatriz Gonzalez: Distribucion y Caracteristicas de la Investigacion en Salud en Colombia (Distribution and Characteristics of Health Research in Colombia); Bogota, IDRC/LARO, 1985.

B) BRAZIL:

1) Ministerio das Minas e Energia: Modelo Energetico Brasileiro (Brazilian Energy Model); Brasilia, Ministerio das Minas e Energia, 1984.

2) R. Ch. Mafra: Agricultura de Sequeiro no Tropico Semi-Arido: Um Delineamiento de Compromisso Para Acao da Pesquisa (Agriculture in the Dry Areas of the Semi-Arid Tropics: Directions for Research); Recife, Empresa Pernambucana de Pesquisa Agropecuaria, 1981.

3) CNPq: Ciencia e Tecnologia em Alimentos e Nutricao: Desempenho do Setor no Periodo 1975-1979 (Science and Tchnology in Food and Nutrition: Performance of the Sector From 1975 to 1979); Brasilia, CNPq, Coordenacao Editorial, 1981.

4) CNPq: III Plano Basico de Desenvolvimento Cientifico e Tecnologico 1980-1985 (III Basic Plan for Scientific and Technological Development (1980-1985); Brasilia, CNPq, 1980.

5) CNPq: III PBDCT - Acao Programada em Ciencia e Tecnologia: Saude e Nutricao (Program of Action in Science and Technology: Health and Nutrition); Brasilia, CNPq, 1982.

6) CNPq: A Questão da Informatica no Brasil (Informatics in Brazil); Brasilia, CNPq, 1985.

ANNEX II (Cont.)

C) MEXICO:

Instead of attempting to formulate sectorial research and technological development programs, CONACYT in Mexico made an effort to formulate an overall national plan for research and technological development, covering different sectors. See CONACYT: Programa Nacional de Desarrollo Tecnologico y Cientifico 84-88 (National Program of Scientific and Technological Development); Mexico, CONACYT, 1984. This national plan has chapters on:

1) Agriculture and fisheries.
2) Agroindustry.
3) Technological development in the main industrial branches (electronics, petrochemical, metalworking industry).
4) Renewable and non-renewable natural resources.
5) Urban development, housing and education.
6) Mines and energy.

D) COSTA RICA:

1) CONICIT: Diagnostico de la Agroindustria en Costa Rica (Analysis of Agroindustry in Costa Rica); San Jose, CONICIT, 1983.

E) AT A REGIONAL LEVEL:

1) INTERCIENCIA: Programa INTERCIENCIA de Recursos Biologicos (INTERCIENCIA Bioresources Regional Program); Bogota, INTERCIENCIA, 1984.

2) CIAT: Amazonia: Investigacion Sobre Agricultura y Uso de Tierras (Research on Agriculture and Land Use in the Amazon); Proceedings of an International Meeting; Cali, CIAT, 1982.

A N N E X III

COMMENTS ON SCIENCE AND TECHNOLOGY INDICATORS

Most of the S and T indicators related to research (not referring to other aspects of S and T policy), are input indicators (basically related to human resources, financial resources and other input resources that are dedicated to research). At the other extreme, we have a few (and very weak) output indicators, such as publications and patents. There is obviously a clear lack of:

a) Performance or efficiency indicators (related more to how the research process is being carried out, the efficiency with which resources are being used, the quality of the work done, the adequacy of the research approach used, etc.).

b) Improved output indicators, specially more relevant for developing countries (not only publications and patents); and

c) Indicators related to the actual use of research results (i.e. technological innovations or other applications), and to their development impact (impact indicators and impact analysis).

This clearly defines some of the main issues and weaknesses in the area of S and T indicators. Nevertheless, two important factors limit the development of "indicators" in this area:

a) Not all aspects of S and T policy (nor even of research policy) are amenable to be analyzed or expressed through indicators (at least not of the quantitative type). The policy-maker will simply have to rely on common sense, his own knowledge of the situation and qualitative information and analysis (i.e. case studies, state-of-the-art reviews, etc.). S and T policy can never be reduced to a mechanical manipulation of indicators, following cookbook formulas.

b) A second important consideration is that even if progress is made in developing or improving S and T indicators related to the three aspects mentioned above, simple input indicators will continue to be not only useful, but necessary, for policy-makers. The latter have to know where is the money going to, how is it being spent, what's the level of training of researchers and how are they being used (distribution), etc. Policy makers need the type of aggregate data related to input indicators, despite the fact that these indicators do not provide the more sophisticated and qualitative information of the other three types of indicators. The latter will obviously complement and enrich the information given by the former, but will never replace them.